

CALIBRATION STANDARD SPECIFICATION
FOR A
THERMAL RMS DIGITAL MULTIMETER
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PROCUREMENT PACKAGE

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THERMAL RMS DIGITAL MULTIMETER

1. SCOPE

1.1 Scope. This specification defines the mechanical, electrical, and electronic characteristics for a Thermal RMS Digital Multimeter. This equipment is intended to be used by Navy personnel in shipboard and shore based laboratories to calibrate DC Voltage, true RMS AC voltage, and resistance. For the purposes of this specification, the Thermal RMS Digital Multimeter shall be referred to as the TRDM.

2. APPLICABLE DOCUMENTS

2.1 Controlling Specifications. MIL-T-28800, "Military Specification, Test Equipment for use with Electrical and Electronic Equipment, General Specification for," and all documents referenced therein of the issues in effect on the date of the solicitation shall form a part of this specification.

3. REQUIREMENTS

3.1 General. The TRDM shall conform to Type II, Class 5, Style E requirements as specified in MIL-T-28800 for Navy shipboard and shorebased use as modified below. The use of material restricted for Navy use shall be governed by MIL-T-28800.

3.1.1 Design and Construction. The TRDM design and construction shall meet the requirements of MIL-T-28800 for Type II equipment.

3.1.2 Power Requirements. The TRDM shall operate from a source of 103.5 V to 126.5 V at 50 and 60 Hz $\pm 5\%$ single-phase input power as specified in MIL-T-28800.

3.1.2.1 Fuses or Circuit Breakers. Fuses or circuit breakers shall be provided. If circuit breakers are used, both sides of the power source shall be automatically disconnected from the equipment in the event of excessive current. If fuses are used, only the line side of the input power line as defined by MIL-C-28777, shall be fused. Fuses or circuit breakers shall be readily accessible.

3.1.2.2 Power Connection. The requirements for power source connections shall be in accordance with MIL-T-28800 with a 6-foot minimum length cord.

3.1.3 Dimensions and Weight. Maximum dimensions shall not exceed 17 inches in width, 6 inches in height, and 24 inches in depth. The weight shall not exceed 35 pounds.

3.1.4 Lithium Batteries. Per MIL-T-28800, lithium batteries are prohibited without prior authorization. A request for approval for the use of lithium batteries, including those encapsulated in integrated circuits, shall be submitted to the procuring activity at the time of submission of proposals. Approval shall apply only to the specific model proposed.

3.2 Environmental Requirements. The TRDM shall meet the environmental requirements for Type II, Class 5, Style E equipment with the deviations specified below.

3.2.1 Temperature and Humidity. The TRDM shall meet the conditions below:

	<u>Temperature (°C)</u>	<u>Relative Humidity (%)</u>
Operating	10 to 30	95
	30 to 40	75
Non-operating	-40 to 70	Not Controlled

3.2.2 Electromagnetic Compatibility. The electromagnetic compatibility requirements of MIL-T-28800 are limited to the following areas: CE01, CE03, CS01, CS02, CS06, RE01, RE02 (14 kHz to 1 GHz), and RS03.

3.3 Reliability. Type II reliability requirements are as specified in MIL-T-28800.

3.3.1 Calibration Interval. The TRDM shall have an 85% or greater probability of remaining within tolerances on all specifications at the end of a 12 month period.

3.4 Maintainability. The TRDM shall meet the Type II maintainability requirements as specified in MIL-T-28800 except the lowest discrete component shall be defined as a replaceable assembly. Certification time shall not exceed 60 minutes.

3.5 Performance Requirements. The TRDM shall provide the following capability as specified below. Unless otherwise indicated, all specifications shall be met following a 2-hour warm-up over the temperature range of $\pm 5^{\circ}\text{C}$ from the temperature at which external calibration is performed (within 18°C to 28°C) for a minimum period of 12 months.

3.5.1 True RMS AC Voltage Measurements.

3.5.1.1 Range. AC voltage measurement range shall be at least 12.5 mV to 600 V rms. The TRDM shall have an autoranging feature that selects the optimum measurement range.

3.5.1.2 Frequency. The TRDM shall have the capability to measure AC voltages over a frequency range from 10 Hz to 1 MHz.

3.5.1.3 Coupling. The TRDM shall have AC coupling modes of AC and AC plus DC.

3.5.1.4 Resolution. The TRDM resolution shall be equal to or less than the following:

5-1/2 digit mode: 10 PPM
6-1/2 digit mode: 1 PPM (1 volt range and higher)

3.5.1.5 Volt Hertz Product. The volt hertz product shall be 1×10^7 , minimum.

3.5.1.6 Overrange. Display overrange shall be at least 20 percent of range.

3.5.1.7 AC Voltage Uncertainty. The uncertainty of the true rms voltage readings traceable to the National Institute of Standards and Technology (NIST) shall not exceed the following within each measurement range. (Within 1 hour of the DC zero being set.)

Uncertainty: \pm (Percent of Reading)

Frequency (Hz)	Measurement Range				
	25-120 mV	0.1-12 V	10-36 V	35-120 V	Above 120 V
10 to 40	0.152	0.152	0.152	0.152	0.172
40 to 20k	0.041	0.025	0.025	0.025	0.045
20k to 50k	0.083	0.083	0.083	0.083	0.108
50k to 100k	0.308	0.308	0.308	0.308	0.358
100k to 200k	0.789	0.689	0.689	1.189	----
200k to 500k	2.04	2.04	4.04	4.04	----
500k to 1M	4.49	4.49	12.99	----	----

3.5.1.8 Crest Factor. The crest factor shall be up to 8:1 for input signals with peaks less than two times full scale, and highest frequency components within the 3 dB bandwidth.

3.5.1.9 Overload protection. The TRDM shall withstand an overload of 600 V rms or DC on any range.

3.5.1.10 Common Mode Rejection. The TRDM common mode rejection shall be greater than 120 dB at DC to 60 Hz.

3.5.1.11 Input Impedance. The TRDM input impedance shall be 1 megohm or greater shunted by less than 180 pf.

3.5.1.12 Settling Time. The TRDM settling time shall be 3 seconds or less for 5-1/2 digit display and 6 seconds or less for 6-1/2 digit display.

3.5.1.13 Bandwidth. The TRDM 3 dB bandwidth shall be 3 MHz for the 100mV range and 10 MHz for the 300 mV, 1 V, 3 V, and 10 V ranges.

3.5.2 DC Voltage Measurements.

3.5.2.1 Range. DC voltage measurement range shall be 0 V to 1,000 VDC. The TRDM shall have an autoranging feature that selects the optimum measurement range.

3.5.2.2 Modes. The TRDM shall have DC operating modes of normal and average (filtered).

3.5.2.3 Resolution. The TRDM shall have a resolution of 0.1 PPM or less on the 10 V range and 1 PPM or less on the other ranges.

3.5.2.4 Overrange. The TRDM shall have an overrange display of at least 20 percent of range.

3.5.2.5 DC Voltage Uncertainty. The uncertainty of DC voltage measurement traceable to the NIST shall not exceed the following within each measurement range. (Within 1 hour of the DC zero being set.)

DC Voltage Uncertainty
±(Percent of Reading + Number of Counts) (Note 1)

Operating Mode (6-1/2 Digits)

<u>Range</u>	<u>Normal</u>	<u>Average (Filter)</u>
100 mV	0.004 + 91	0.0029 + 9
1 V	0.0024 + 9	0.0021 + 7
10 V	0.0019 + 9	0.0015 + 15
100 V	0.003 + 9	0.0024 + 7
1000 V	0.003 + 9	0.0024 + 7

Note 1: "Number of Counts" is the allowable error in the least significant digit in addition to the percent of reading.

3.5.2.6 Temperature Coefficient. The TRDM temperature coefficient in DC voltage measurements shall be less than 4.0 PPM per °C from 18°C to 10°C and from 28°C to 40°C.

3.5.2.7 Input Resistance. The DC voltage input resistance shall be equal to or greater than 10,000 megohms up to

10 V measurement range, and equal to or greater than 10 megohms above 10 V measurement range.

3.5.3 Resistance.

3.5.3.1 Range. Resistance ranges shall be 0 ohms to 100 megohms. The TRDM shall have an autoranging feature that selects the optimum measurement range.

3.5.3.2 Resolution. The TRDM shall have a resolution as shown below.

5-1/2 digit mode: 10 PPM
6-1/2 digit mode: 1 PPM

3.5.3.3 Overrange. The TRDM shall have an overrange display of at least 20 percent of range.

3.5.3.4 Current Through Unknown Resistance. Current through the unknown resistance shall be 10 mA maximum on low resistance ranges, decreasing to 1 uA maximum on high resistance ranges.

3.5.3.5 Resistance Measurement Uncertainty. The absolute uncertainty of resistance measurement traceable to the NIST shall not exceed the values shown on the table below within each scale range.

RESISTANCE UNCERTAINTY	
±(Percent of Reading + Number of Counts) (Note 1)	
<u>Measurement Range</u>	<u>Uncertainty (5-1/2 digits)</u>
0 to 10 ohm	0.010 + 20
10 to 100 ohm	0.006 + 2
100 to 1k ohm	0.006 + 1
1k to 10k ohm	0.006 + 1
10k to 100k ohm	0.006 + 1
100k to 1M ohm	0.006 + 1
1M to 10M ohm	0.04 + 1
10M to 100M ohm	0.1 + 1

Note 1: "Number of Counts" is the allowable error in the least significant digit. For 6-1/2 digit display, multiply number of counts by 10.

3.5.3.6 Measurement Configuration. Two-wire measurement on all ranges and four-wire selectable on 10 ohm through 100k ohm measurement ranges.

3.5.3.7 Settling Time. The TRDM settling time for resistance measurements shall not exceed 1 second.

3.5.3.8 Overvoltage Protection. The TRDM shall withstand a voltage of ± 400 VDC or peak AC on any range.

3.6 Operating Requirements. The TRDM shall provide the following operating capabilities.

3.6.1 Front Panel Control Requirements. All modes and functions shall be operable using front panel controls. The locations and labeling of indicators, controls, and switches shall provide for maximum clarity and easily understood operation without reference to tables, charts, or flow diagrams.

3.6.2 Programmability. All modes and functions shall be fully remotely programmable via the IEEE-488.1 instrumentation bus. When operating the TRDM via remote programming, all front panel controls shall be disabled, except for the on / off switch and the Remote / Local switch.

3.6.3 Error Correction. During calibration, the TRDM shall provide the capability to accept and store corrections for all measurement deviations from nominal conditions. This correction capability shall be operational from the front panel control and over the IEEE-488 bus. When the TRDM is operated within its calibration period, it shall meet all the specified performance specifications without requiring the additional entry of any calibration factor or other correction data by the operator, including correction data entered by an instrument controller.

3.6.4 Local / Remote. The TRDM shall have a local and remote operation mode. It shall be either manually or remotely programmable selectable according to paragraph 3.6.2. Manual selection shall be provided by a front panel switch. A means of indicating the operational mode shall be provided. When changing modes, all parameter values shall remain unchanged.

3.6.5 Self-Test. The self-test shall comprise two selectable levels, an operational test to determine if the instrument is operationally ready, and second level diagnostic test to diagnose and isolate faulty field replaceable modules. When the self-test function is initiated, an auto-sequenced internal operational test shall be performed. The diagnostic test shall be selectable only by deliberate operator command.

3.6.6 IEEE Interface. The TRDM shall have an IEEE-488.1 interface connector with the following capabilities: SH1, AH1, T6, L4, SR1, RL1, DT1. Serial poll capability shall be provided.

3.6.7 Compatibility. The TRDM shall be tested for compatibility with the IEEE-488 bus and the John Fluke model 1722A/AP instrument controller, and shall respond identically as the John Fluke model 8506AAN.

3.6.7.1 Automated Calibration Procedure Conformance. The TRDM, when utilized by the Navy's automated calibration procedures in conjunction with a Fluke 1722A/AP instrument controller shall be compatible with those procedures without the loss of the performance or operational requirements of this specification or those procedures. The TRDM shall be compatible with the Navy's automated calibration procedures with no revision to said procedures.

3.7 Manual. At least two copies of an operation and maintenance manual shall be provided. The manual shall meet the requirements of MIL-M-7298.

3.7.1 Calibration Procedure. The manual shall provide a calibration procedure for the TRDM in accordance with MIL-M-38793.

3.8 Accessories. The TRDM shall include the following:

3.8.1 One set of low thermal emf, shielded input cables.

3.8.2 One test lead kit with interchangeable tips (alligator, spade lug, hook, and pin).

3.8.3 One four-terminal short for zeroing the TRDM for system calibration.

3.8.4 One IEEE-STD-488-1978 cable, 6 feet minimum length.

3.8.5 One power cable with minimum length of 6 feet.